KEYSIGHT

Generation and Analysis of wideband complex signals

RF Seminars – May 2024

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Agenda

- Industry Trends in Wireless Communications
- MXG N5186A Signal Generator
- UXA N9042B Signal Analyzer
- PathWave Signal Generation and VSA Software
- Demo: Generation and Demodulation of 5G NR Signals
- Extra: How to set up a complex and dense wireless environment

Industry Trends in Wireless Communications

New Applications Are Driving New Requirements

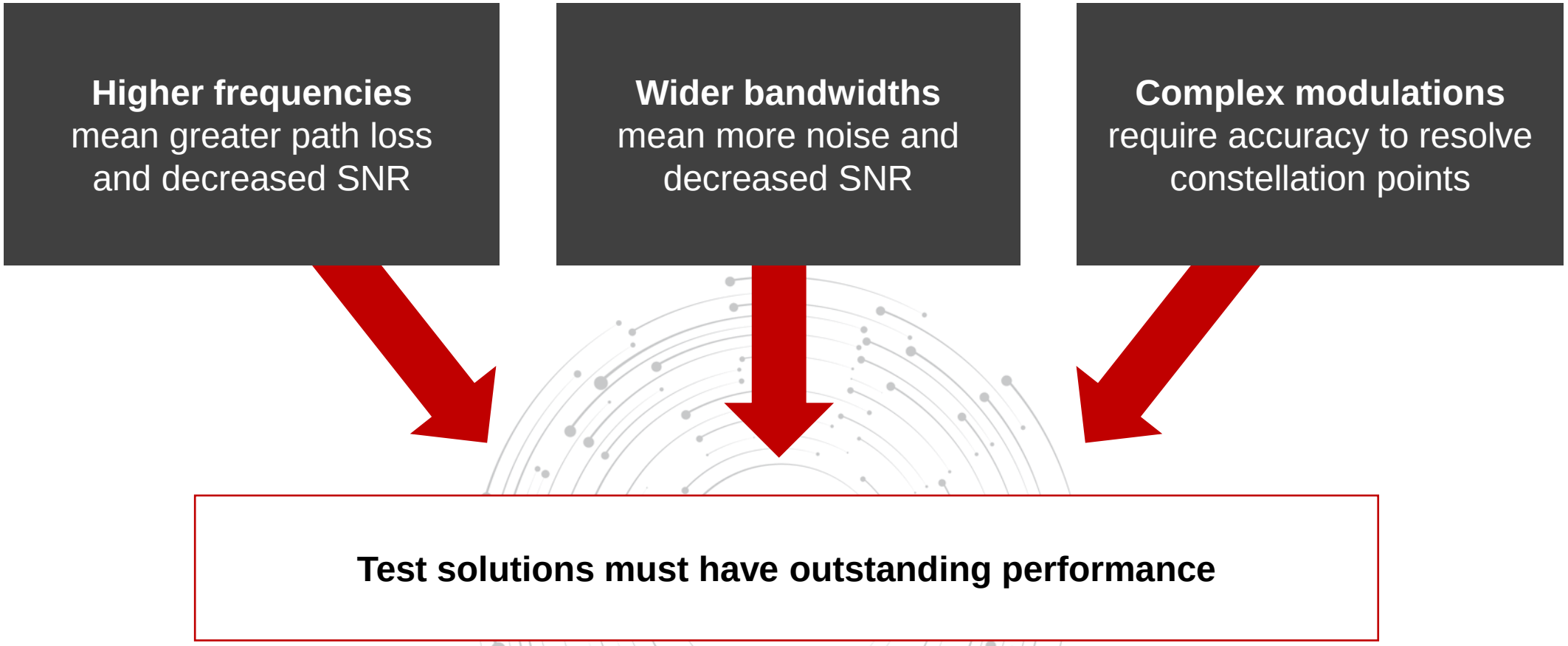
Mobile Device

BTS/Receiver

Satellite Communications

EMSO

Challenges


Higher frequencies mean greater path loss and decreased SNR
Wider bandwidths mean more noise and decreased SNR
Complex modulations require accuracy to resolve constellation points
Test solutions must have outstanding performance

N5186A MXG Signal Generator

Keysight Signal Generator

Find your optimum performance

CXG

Multi-Functional

9 kHz to 6 GHz, 120 MHz BW

EXG

Cost-effective

9 kHz to 6 GHz, 160 MHz BW

9 kHz to 40 GHz

MXG

Pure and Precise

9 kHz to 8.5 GHz, 960 MHz BW

9 kHz to 6 GHz, 160 MHz BW

9 kHz to 40 GHz

PXI SG

Flexible and Scalable

1 MHz to 44 GHz, 1 GHz BW

PSG

Metrology Grade

100 kHz to 44 GHz, 80 MHz BW

100 kHz to 67 GHz

VXG

Multi-Channel

1 MHz to 44 GHz, 2 GHz BW

9 kHz to 54 GHz, 2.5 GHz BW

UXG

Fast-switching

10 MHz to 40 GHz, 1.6 GHz BW

New Requirements Need New Test Instruments

Keysight's Next-Generation Midrange Vector Signal Generator

New!

N5182B Vector MXG

N5186A Vector MXG

Next-Gen Mid-Range Source: N5186A MXG

THE CHALLENGE

- New applications are requiring complex modulations, higher frequencies, wider bandwidths, multiple antenna techniques, and **more sources in smaller spaces**

THE APPROACH

- Add wideband, multi-channel signal generation to a mid-range source by increasing port count, bandwidth, and higher frequency, while maintaining density

ONE 4-channel N5186A MXG

FOUR 1-channel N5182B MXGs

Introducing the N5186A MXG Vector Signal Generator

Advanced architecture with size in mind

- High performance **DDS DAC technology** leveraged from M9484C VXG
- Simplify complex test setups with up to **4 channels in 1 box**
- Meet narrow and wideband requirements with up to **960 MHz bandwidth**

Integrated innovation at your fingertips

- 1st signal generator with an **embedded reflectometer** for fixture removal
- Seamlessly create complex modulations directly on the screen using **PathWave**
- Ease-of-use with a **premium user experience**

Multi-Channel Configurations

1 Channel

Max frequency: 3, 6, or 8.5 GHz

4 Channels

Max frequency: 3, 6, or 8.5 GHz

Best-in-Class Bandwidth vs. Density

Generate complex test signals

Create any standards-based waveform – and more all in a 2U box!

- Generate signals with up 960 MHz modulation bandwidth per channel
- Factory calibrated for magnitude and phase across frequency and all attenuator states
- Ready for intra- and inter-band aggregation with up to 3.84 GHz per instrument

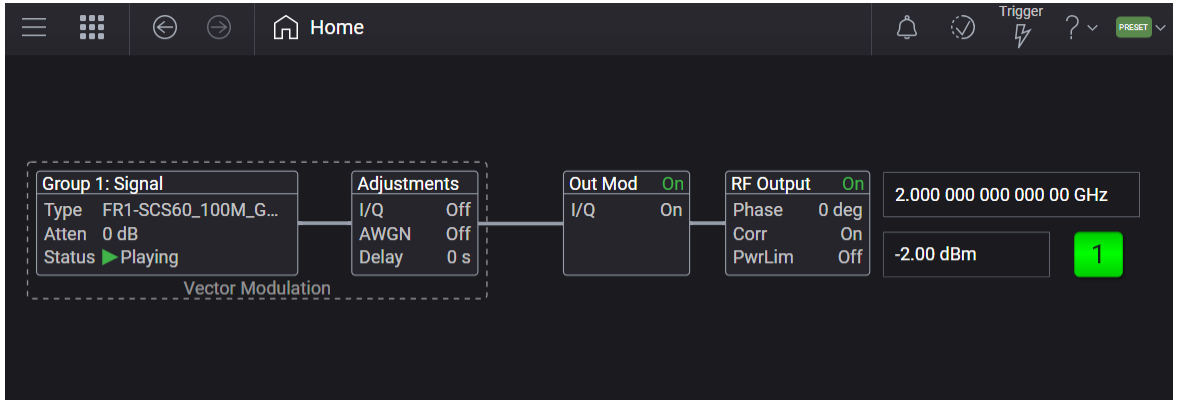
KEYSIGHT

Enhanced User Experience

Premium quality

Premium quality with updated interface enables ease-of-use and expedites time-to-first measurement

- Modern and intuitive
  - Seamlessly transition and setup your signal using the new PathWave graphical user interface
  - New halo lighting indications around each channel removes guesswork in crowded environments
- Ergonomic, high-quality design
  - More room to create with a 20% larger, higher-resolution touchscreen display than the N5182B
  - Smoother knob for more comfortable handling and faster revolutions

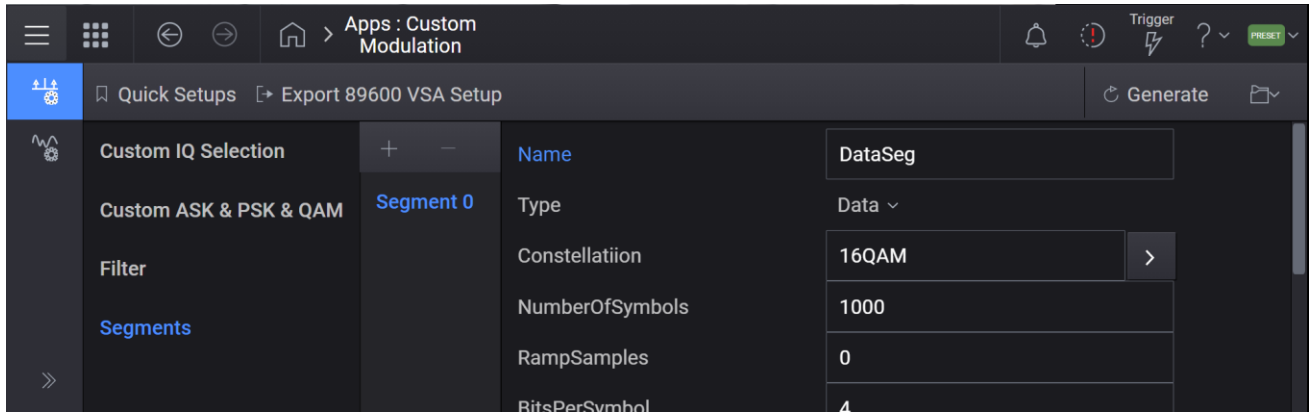


Comprehensive Software

PathWave signal generation

Ensure designs meet the latest standards and test requirements for wireless and EMSO applications

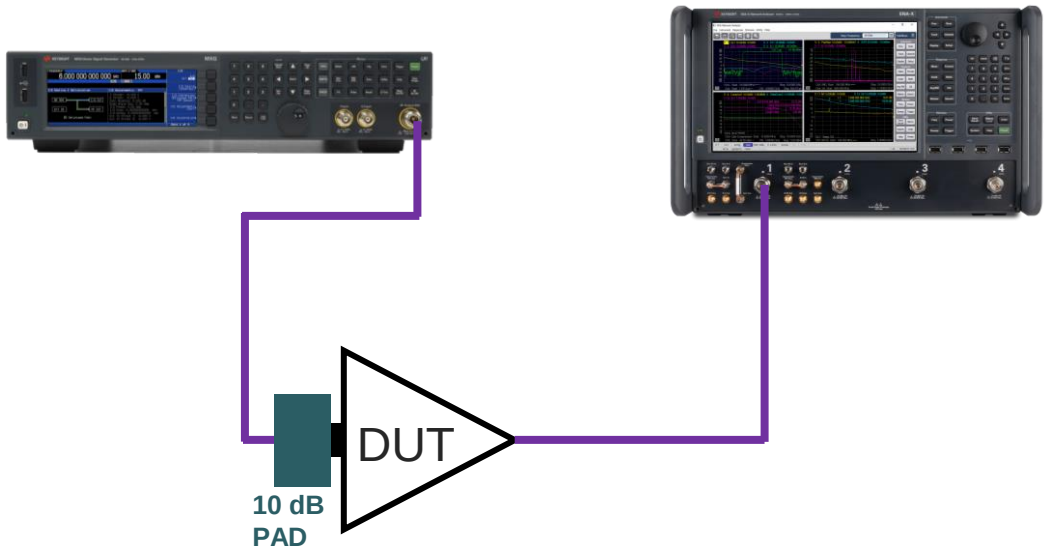
- Create custom OFDM and IQ waveforms for emerging wireless and aerospace/defense custom/proprietary applications
- Immediate playback for custom IQ modulation, IQ based AM/FM/phase, and multitone waveforms using the embedded PathWave software tools



Embedded Reflectometer

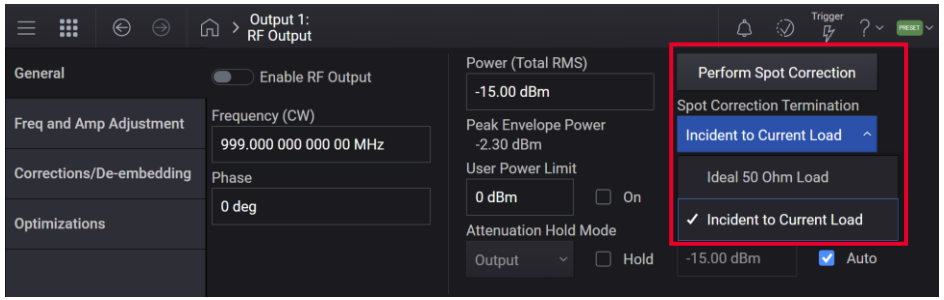
Accelerate workflow with one button

Before



- Requires VNA to characterize DUT match
- Requires a PAD to improve mismatch, degrades power
- Requires measurement uncertainty calculations
- Process consumes hours or days

After



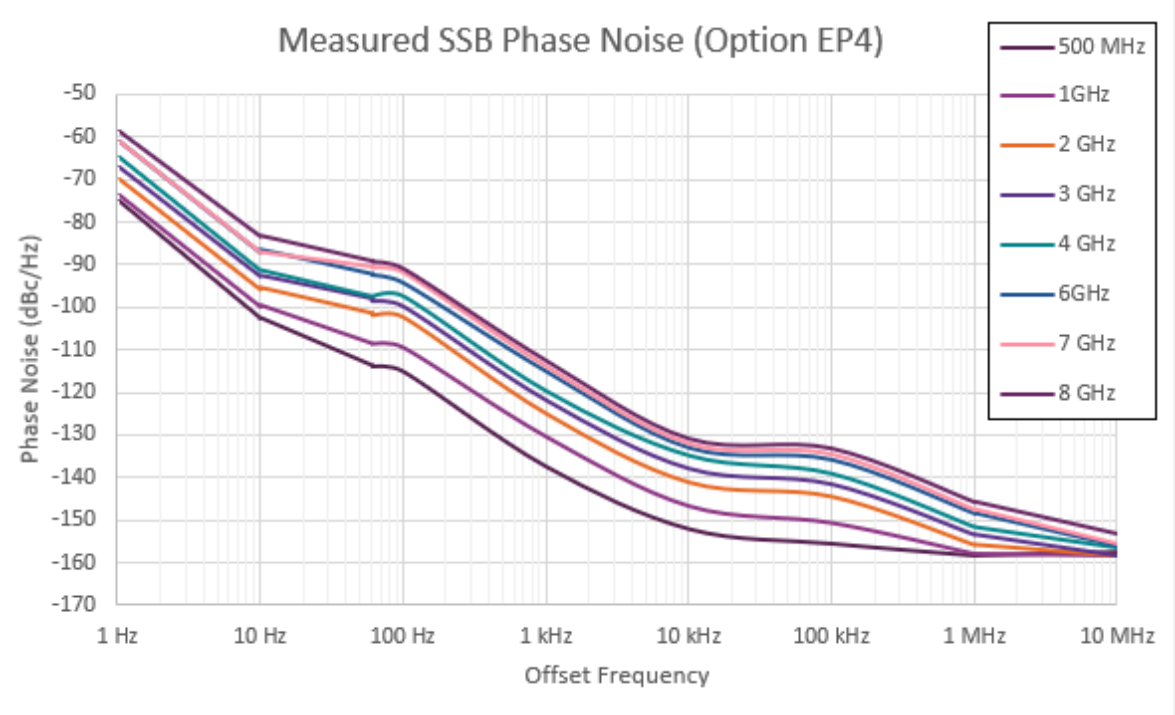
- Requires N5186A-V08 (embedded reflectometer)
- Reduces manual calculations and errors
- Process executes in minutes

Maximize Measurement Integrity

Enhanced phase noise performance

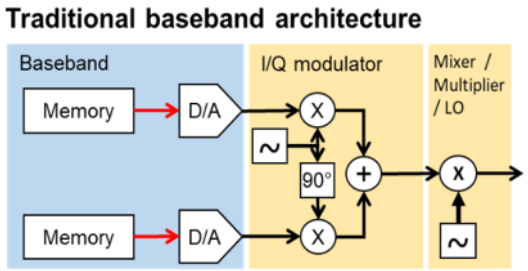
Designed with exceptionally low phase noise to produce pure signals

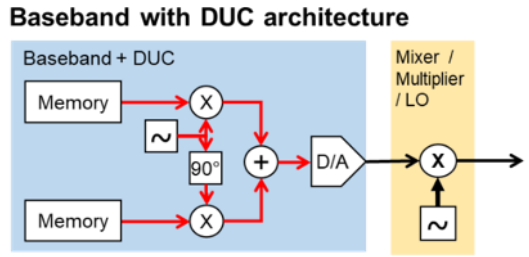
- Enable high-resolution **radar system** designs
- Deliver high-throughput in next-generation **communication system** designs



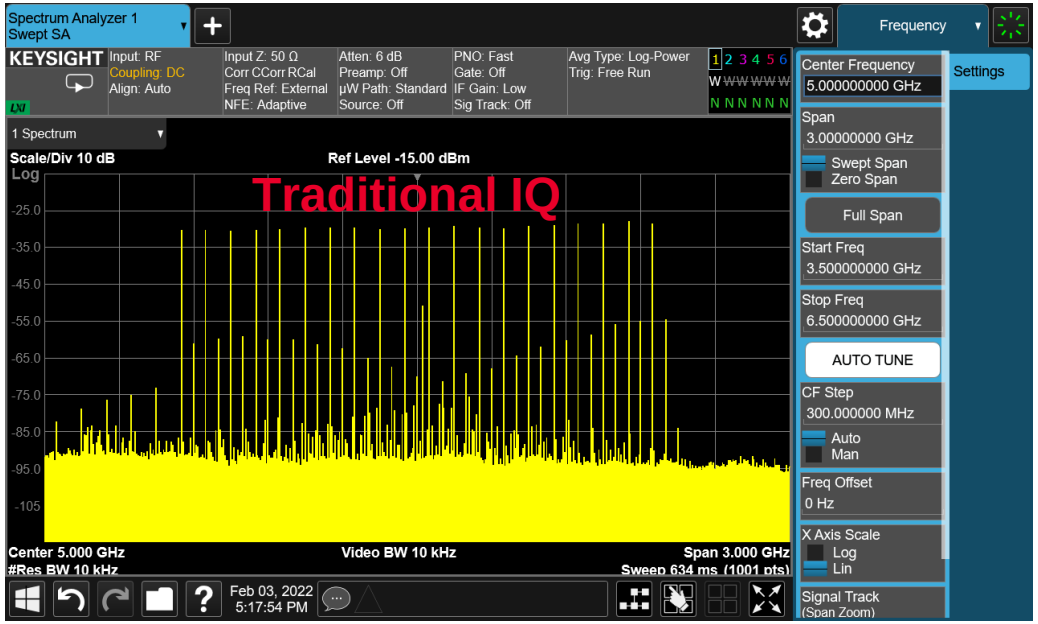
Comparison of Analog vs. Digital Up-Conversion

IQ modulator images degrade dynamic range

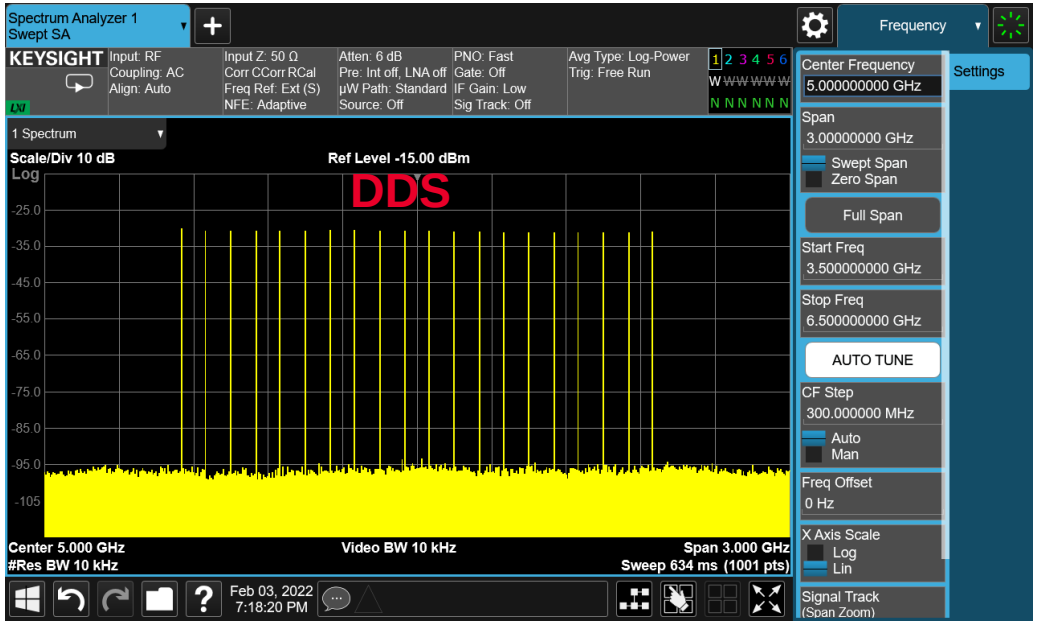


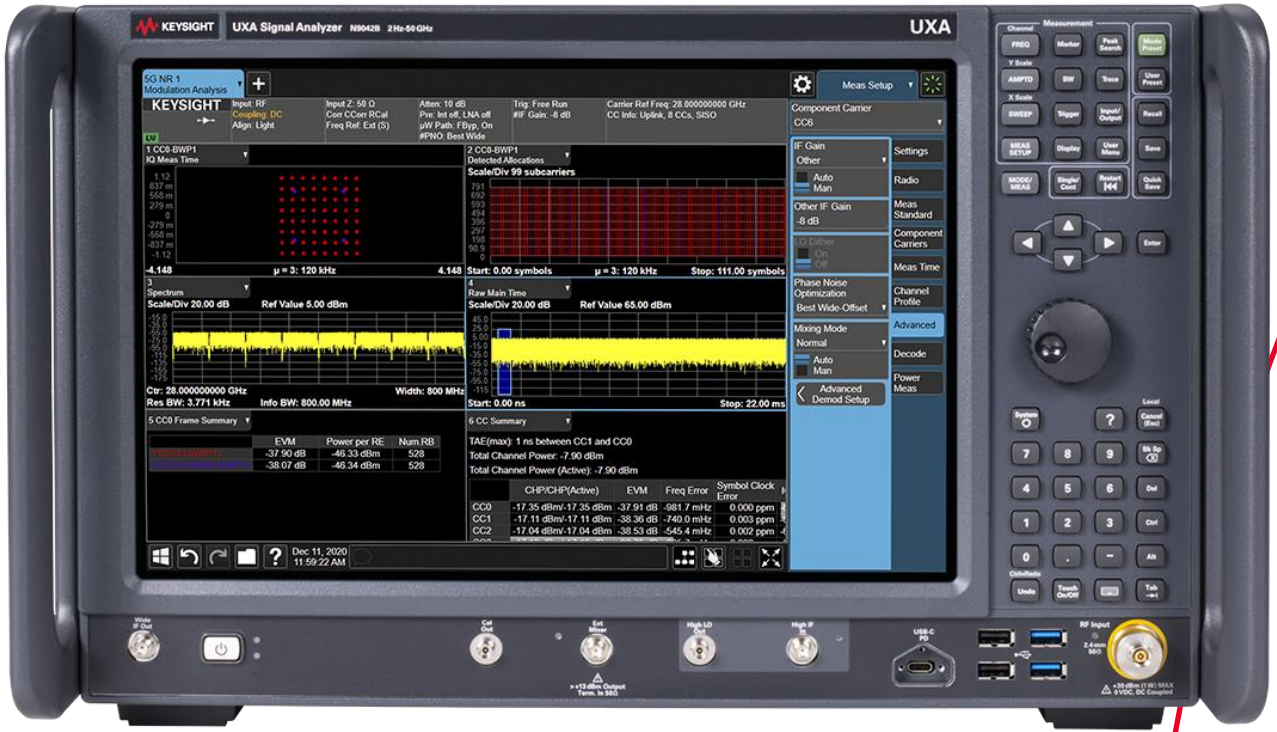


Analog I/Q up-conversion *causes distortion*



Digital up-conversion *avoids distortion*





UXA N9042B Signal Analyzer

Keysight Signal Analysis Portfolio

Common X-Series user interface

Real-time

MXE EMI receiver
Keep the test queue flowing
3 Hz to 44 GHz

Real-time

PXE EMI receiver
Significantly reduce test time
1 Hz to 44 GHz

Real-time

N9040B UXA
2 Hz to 50 GHz
1 GHz max. BW

Real-time

N9041B UXA
2 Hz to 110 GHz
1 GHz max. BW internal
5 GHz max. BW external

Real-time

N9042B UXA
2 Hz to 50 GHz
4 GHz max. BW internal
11 GHz max. BW external

Real-time

N9030B PXA
2 Hz to 50 GHz
510 MHz max. BW

Real-time

N9032B PXA
2 Hz to 50 GHz
2 GHz max. BW

Real-time

N9020B MXA
10 Hz to 50 GHz
160 MHz max. BW

Real-time

N9021B MXA
10 Hz to 50 GHz
510 MHz max. BW

N9010B EXA
10 Hz to 44 GHz
40 MHz max. BW

N9000B CXA
9 kHz to 26.5 GHz
25 MHz max. BW

M9421A VXT PXI
60 MHz to 6 GHz
160 MHz max. BW

M9410A/11A VXT PXI
1 MHz to 6 GHz
1.2 GHz max. BW

M9415A VXT PXI
380 MHz to 12 GHz
1.2 GHz max. BW

N9042B UXA X-Series Signal Analyzer

The most advanced signal analyzer on the planet

- Best performance in the industry for **EVM, swept DANL, and dynamic range**
- Industry leading **4 GHz** of corrected bandwidth for **both analysis and generation** (with VXG)
- Premier **measurement software** with X-Series measurement applications and VSA
- Supports world's only RCal receiver calibrator for up to an **order of magnitude improvement in amplitude accuracy**

Keysight's New Flagship Signal Analyzer

#1 Industry's First!

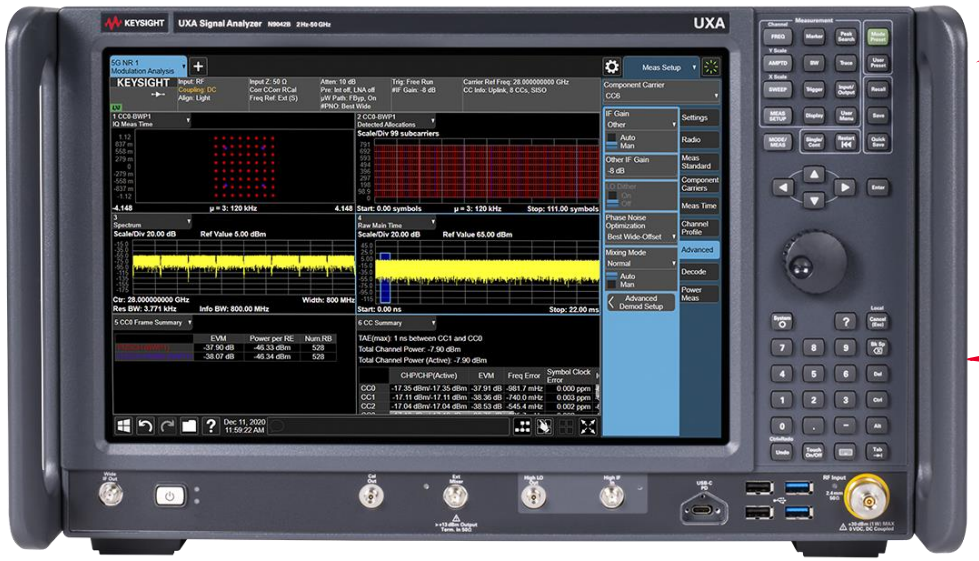
#1
Unique pre-amp architecture:
- 5-8 dB lower DANL
- ~4 dB better EVM sensitivity

#1
Wide analysis BW:
- Up to 4 GHz (Internal)
- 1, 1.5, or 2 GHz options

Up to ~11 GHz (External)
- IF Out to external digitizer
- Cal'ed & controlled by SA

#1
New high-TOI converter:
- ~5 dB better dynamic range
- 2-3 dB lower EVM residuals

New powerful CPU
- Runs X-apps or 89600
- Up to 40% faster



X-Apps Auto Configuration with VXG & PA Test App with DPD

New self-alignment algorithm – Less disruptions

#1
RCal external calibrator AND new internal calibrator:
Best accuracy & IF flatness

N9042B UXA Signal Analyzer
2 Hz – 26.5/44/50 GHz

#1
New V3050A Signal Analyzer Frequency Extender
Seamlessly extend frequency to 110 GHz

Comparisons vs. N9040B UXA

Wide Analysis Bandwidth

Increasing Bandwidth

Up to 11 GHz BW

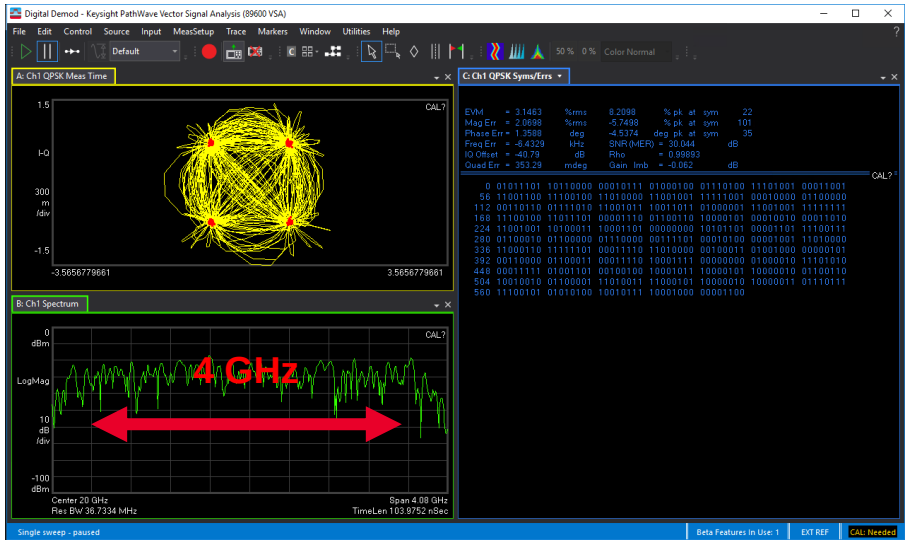
Wideband analog IF output
Supports Keysight oscilloscopes & M8131A AXIe digitizer
26 msec at full 11 GHz
1.6 GB capture memory (with M8131A)
Some digitizers controlled by N9042B

4 GHz BW

12 bits
429 msec at full 4 GHz BW
16 GB capture memory

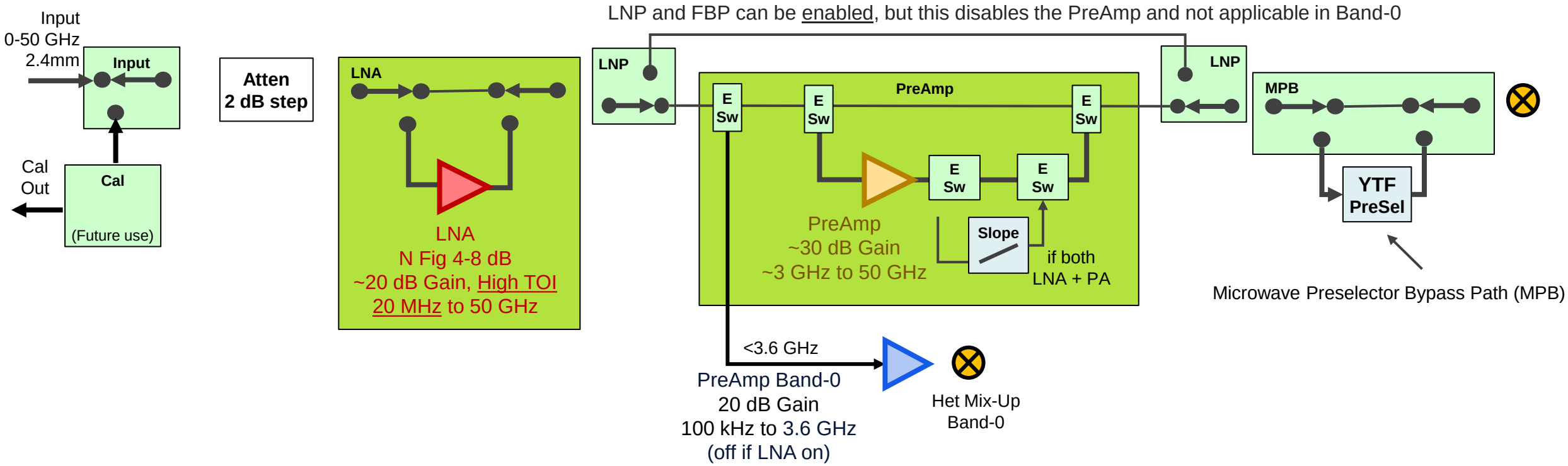
2 GHz BW

14 bits
830 msec at full 2 GHz BW
16 GB capture memory
Also 1 GHz and 1.5 GHz



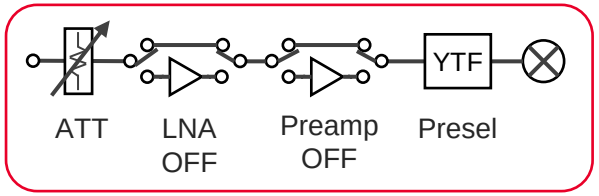
OPTION	ANALYSIS BW	FREQUENCY RANGE (CENTER)
R10	1.0 GHz	0.5 to 50 GHz or 110 GHz
R15	1.5 GHz	0.7 to 50 GHz or 110 GHz
R20	2.0 GHz	3.3 to 50 GHz or 109 GHz
R40	4.0 GHz	10 to 50 GHz or 108 GHz
CRW	Up to 11 GHz	18 to 50 GHz

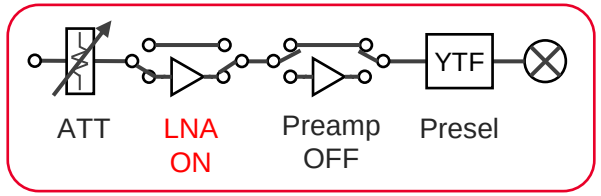
N9042B Front End Paths

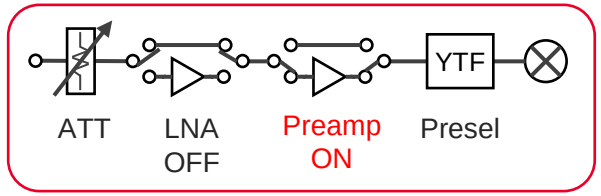


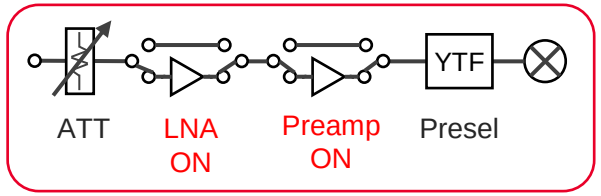
N9040B: 6 paths (including PreAmp on/off)
N9042B: 12 paths (including LNA or PreAmp on/off)

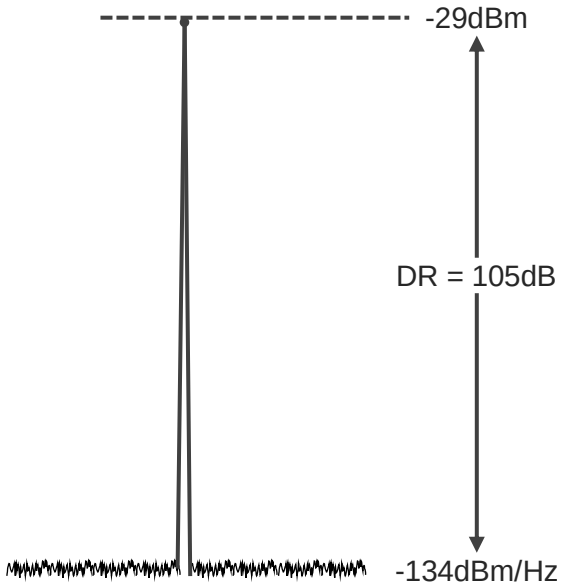
Front End for Swept SA



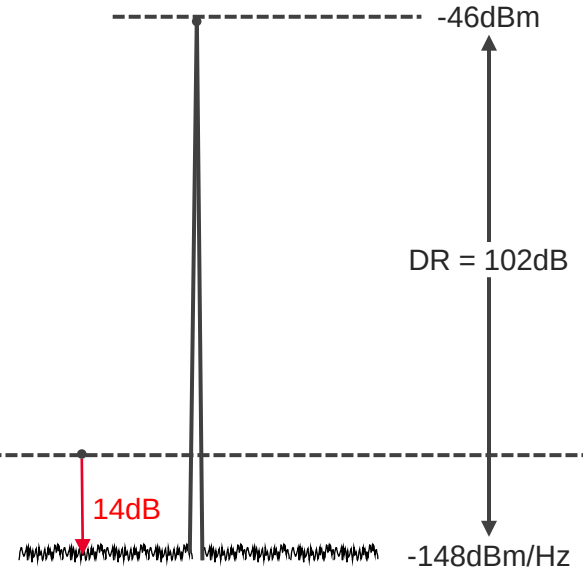


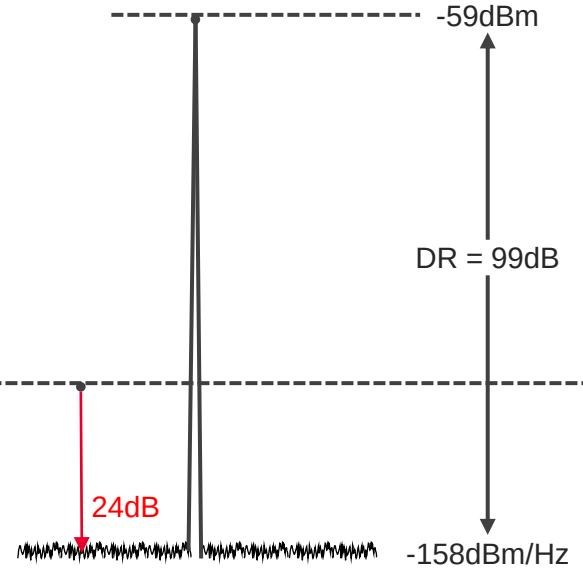


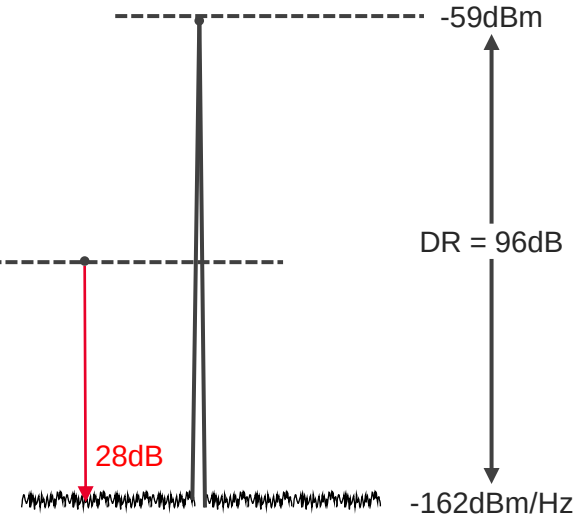




Best Dynamic Range



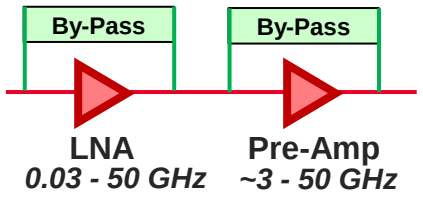




Best Sensitivity

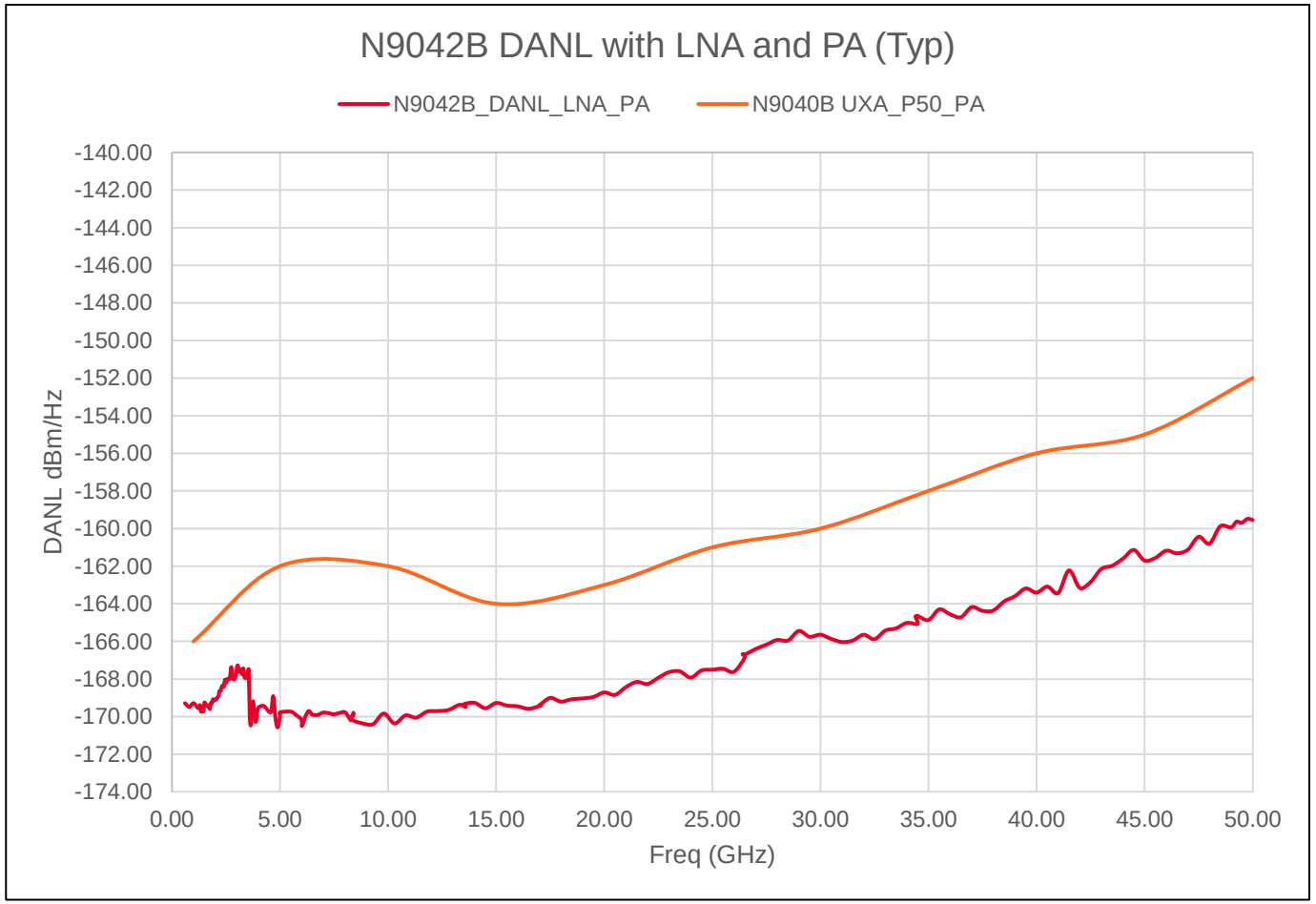
Note1: Examples of 40 GHz (nominal). Effect is not uniform at all frequency.
Note2: 3ODR (3rd-Order Dynamic Range) est. as (2/3)*(TOI-DANL), in 1 Hz

Lowest Swept DANL



New! LNA (Low Noise Amp) drives down noise. Two stages of gain gives greater flexibility to balance noise & distortion.

Both on for best Swept DANL (Sensitivity or Noise Figure), for low-level signals or spurs



PathWave Signal Generation and VSA Software

PathWave RF Test Application Software

FIND THE SOFTWARE THAT'S RIGHT FOR YOU

DESIGN SOFTWARE | TEST SOFTWARE | APPLICATION SOFTWARE | LIBRARIES AND PLUG-INS | IXIA PRODUCTS

PathWave Vector Signal Analysis (VSA)

A comprehensive set of tools for demodulation and vector signal analysis

PathWave Signal Generation

Signal creation for a wide range of general-purpose and standards-based signals

PathWave X-Series Applications

Measurement applications for benchtop and modular signal analyzers

PathWave BenchVue

Software applications for easy instrument control and simplified automation from your desktop

PathWave Test Automation

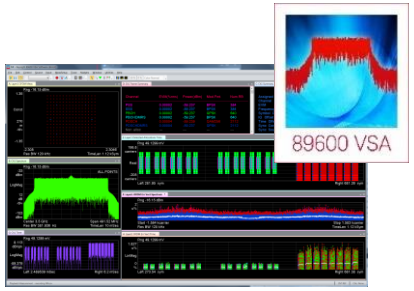
Test sequencer and automation software for data management and test plan development

View All

View All Test Software

https://www.keysight.com/us/en/products/software.html

Keysight Offers Leading RF Test Software Applications



- **PathWave Vector Signal Analysis (89600 VSA)**: The industry-standard for in-depth troubleshooting and analysis across instruments and signal formats

- **PathWave Signal Generation (Signal Studio)**: The leading signal creation and generation software, from simple to complex waveform scenarios

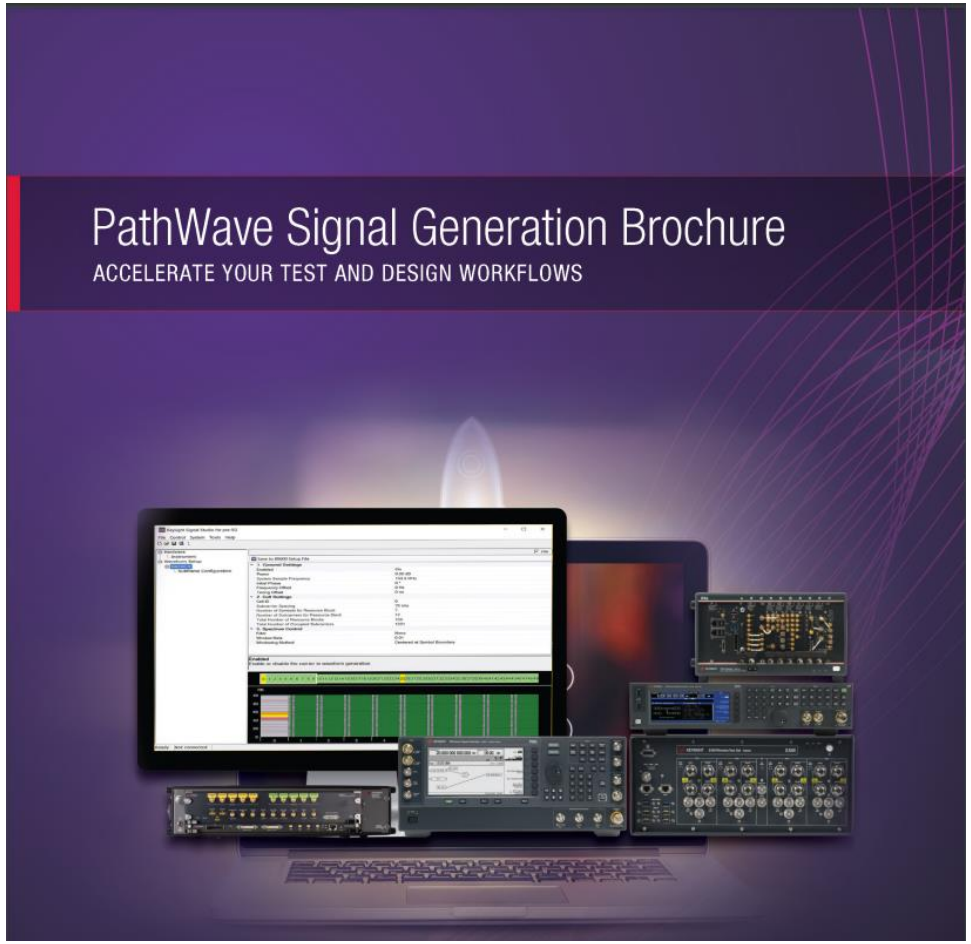
- **PathWave X-Series Measurement Application (X-Apps)**: One-button, embedded measurements to simplify & accelerate characterization of device performance

Same Software Experience Across All HW Platforms

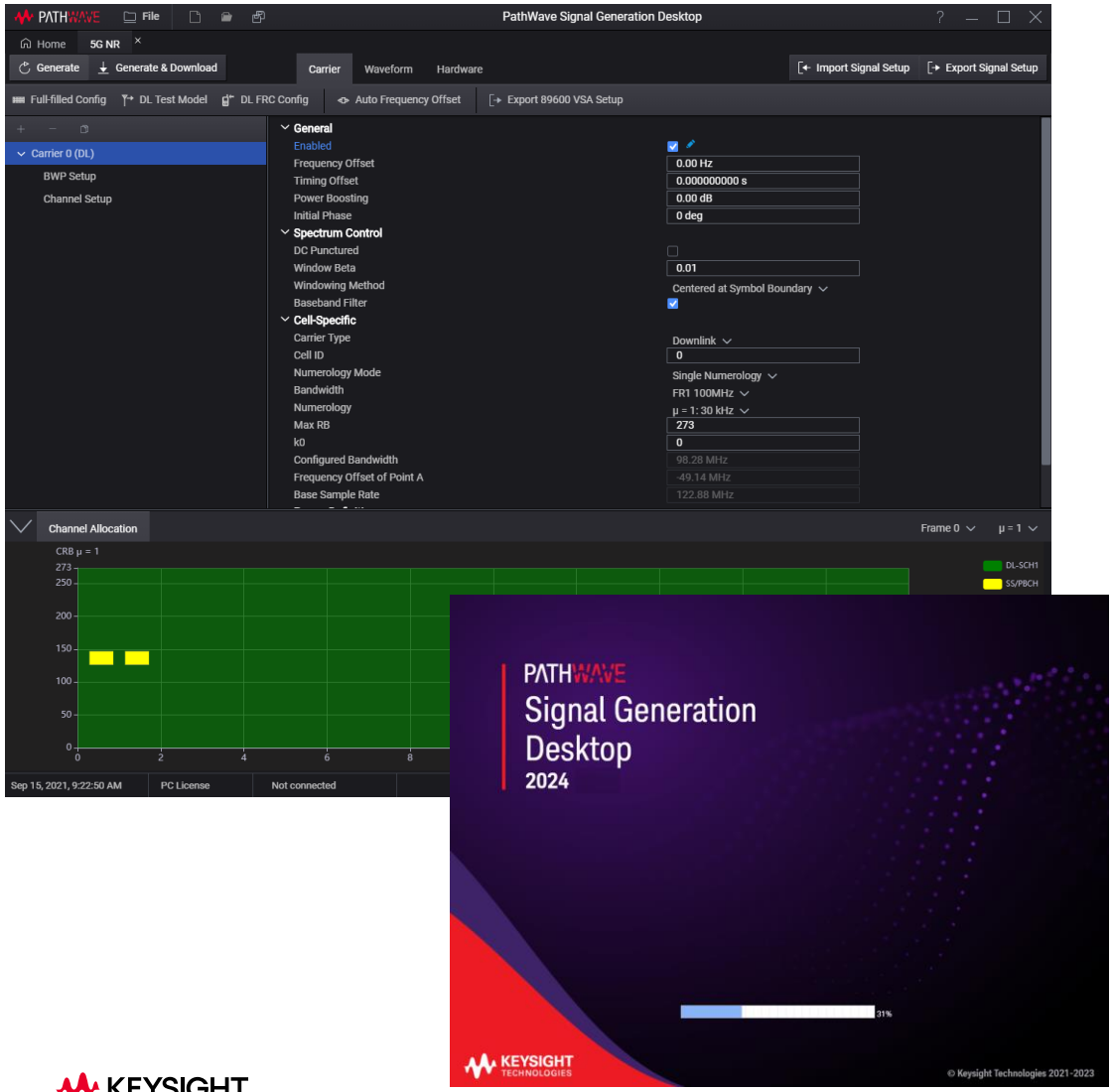
- PathWave RF Test Software Applications run on wide-range of Keysight HW platforms:
  - From high-end to mid-range instruments, and from separated SA/SS benchtop boxes to PXI modular transceivers.
  - Support R&D advanced features with VSA, and DVT/mfg test with optimized X apps
  - Enable same user experience on different HW for both manual operation and automated test
  - Share the 5G NR signal setting and configuration across different apps

PWSG/Signal Studio Software Overview

- Create performance-optimized reference signals that conform to industry standards to characterize your devices with or without impairments. Support wide range of technologies like **5G NR**, **WLAN 802.11ax/be**, **Pulse Radar**, **GNSS**, IoT/**UWB.**
- Easily create and playback customized waveforms for component testing with virtually distortion-free test signals.
- Generate fully channel-coded signals including real-time mode to evaluate the throughput of your receiver. Impairments can be also added to evaluate receiver tolerances.
- Supports a wide variety of signal generators hardware (X-Series Signal Sources, PXI Modular Sources, AWG, VXG, VXT Transceivers).



PathWave Signal Generation (PWSG) Desktop



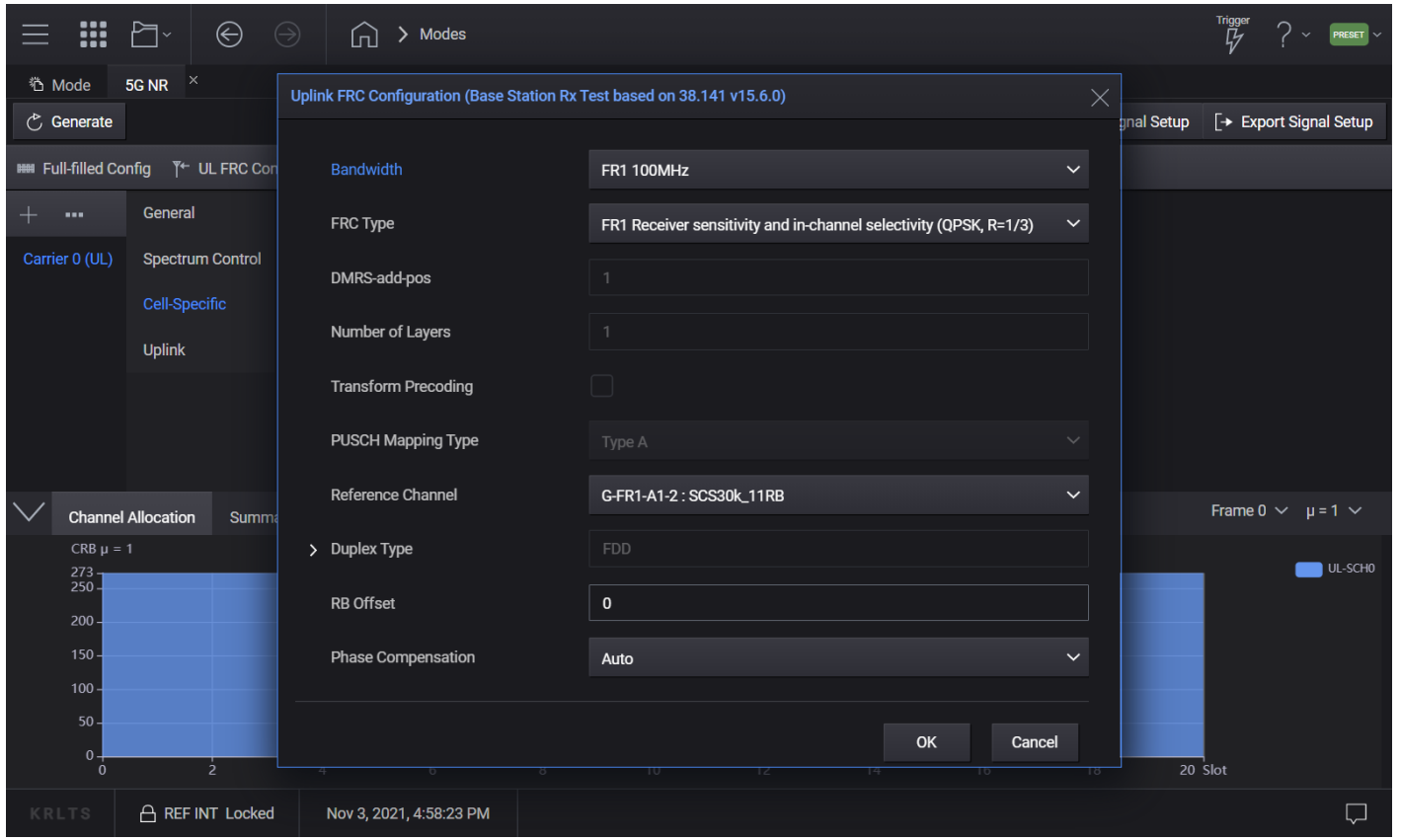
- PathWave Signal Generation (PWSG) Desktop is Keysight's next generation Signal Generation software. It intends to unify various existing Signal Generation applications including Signal Studio, Waveform Creator, Toolkit, and so on. It provides consistent and optimized user experience from R&D through manufacturing to help smoother collaboration.
- **Key Highlights:**
  - Single application hosts multiple radio format "modes"
    - 5G NR mode replaces N7631C Signal Studio Pro for 5G NR (Firstly launched in 2021)
    - Advanced Waveform Utility (New in 2022U1)
    - NR-V2X (New in 2023)
    - Custom Modulation (New in 2024)
    - LTE (New in 2024)
    - Common hardware driver (X-Series SG, VXG, VXT, AWU)
  - Shares same code between Desktop and Embedded
  - Python friendly automation with SCPI
- Supported OS
  - Windows 10 64-bit

PathWave signal generation

5G NR

Ensure designs meet the latest standards and test requirements for wireless and EMSO applications

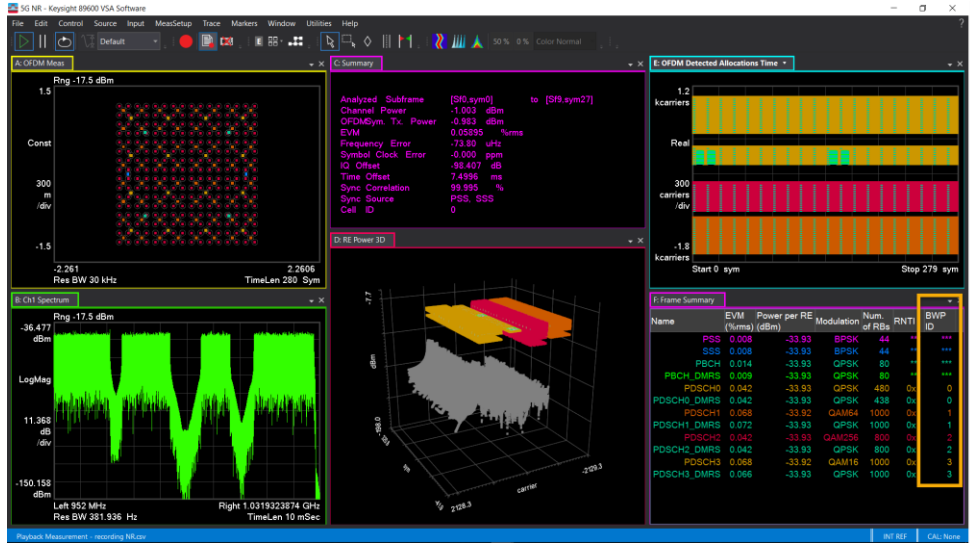
- Test 5G NR receiver performance with **3GPP MIMO fading models** and **real-time HARQ support***
- Create **custom OFDM and IQ** waveforms for satellite, automotive radar, emerging wireless, and aerospace/defense custom/proprietary applications



PathWave 89600 VSA

See through the complexity faster

- VSA (Vector Signal Analysis) software was first invented by HP as the 89400 Series VSA hardware platform.
- 89600 VSA Software continues to be the industry winner since 2001. Support wide range of technologies including **6G Research**, **5G NR**, **802.11ax/be**, **DVB-S2/S2X**, **Pulse**, **FMCW**, **UWB**, **DOCSIS 3.1**.
- 89601C VSA today has **>45 connectivity** with Keysight hardware platforms: signal analyzers and transceivers, oscilloscopes, digitizers, sources, and logic analyzers.
- 89601C VSA also **links to software** like Keysight EDA ADS/SystemVue and supports various file types to playback and analysis (in Matlab format or plain IQ data).
- More flexible with **Custom IQ, Custom OFDM.**
- Best tool for **multi-channel and MIMO** signal analysis.

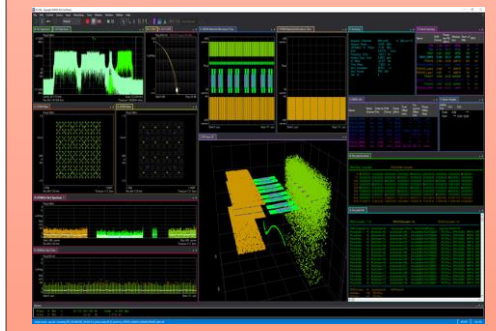


Advanced Design System

SystemVue

PathWave 89600 VSA Overview

Key values to the customers

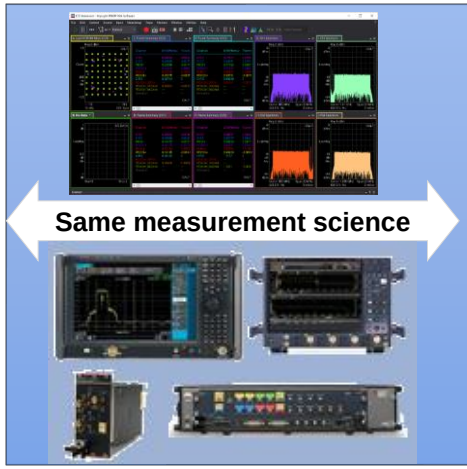


Explore Every Facet of the Signal and Gain More Insights with Intuitive Graphs & Displays

Supports 15+ different measurement apps covering general purpose, aerospace defense, cellular and wireless communications, Internet of Things, with most comprehensive result metrics and displays for troubleshooting complicated issues.

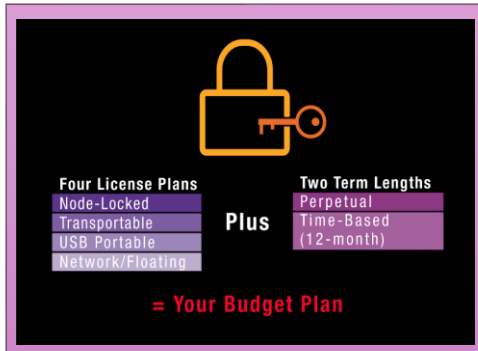
Ensure Designs Meet Latest Standards

Trust that the measurement results are current & forefront with the latest emerging and evolving technologies, with Keysight's involvements and leadership role in standards committees like 3GPP, IEEE, and others.



Share Same Measurement Science and Experience Across Multiple Hardware Platforms

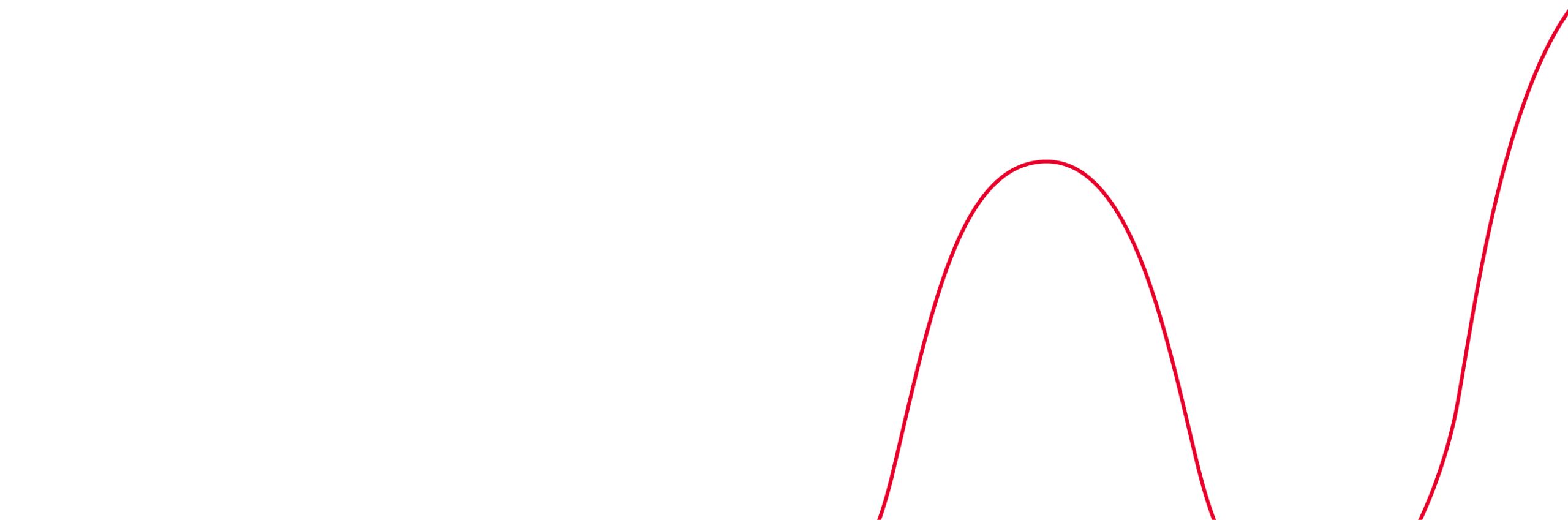
Support widest range of hardware platforms from bench-top SA, PXI SA and transceivers, oscilloscopes, digitizers, logic analyzers, signal sources and 3rd party hardware. Share the same measurement science and user experience across all platforms.



Flexible Choices of License Types & Terms on Your Budget Plan

Offer different license types (node-locked, network floating, transportable and USB) and terms (time-based, perpetual) for different customer use cases. Floating and transportable licenses best fit for R&D labs.

Demo: Generation and Demodulation of 5G NR Signals



Extra topic: How to set up a complex wireless scenario